The status of the Bering Sea: January – August 2000

Phyllis J. Stabeno
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE,
Seattle, WA, 98115 U.S.A.
E–mail: stabeno@pmel.noaa.gov

Dr. Phyllis J. Stabeno, a physical oceanographer at the Pacific Marine Environmental Laboratory (PMEL) of NOAA, conducts research focused on understanding the dynamics of circulation of the North Pacific, Bering Sea and their adjoining shelves. She is the PMEL Director of NOAA Fishery Oceanography Coordinated Investigations (FOCI), and by applying her knowledge of physical processes to fisheries oceanography, she plays a vital role in its success. FOCI research focuses on building sustainable fishery resources in the Gulf of Alaska and Bering Sea while maintaining a healthy ecosystem. Phyllis is also a Principal Investigator on several research elements for other programs, including: Southeast Bering Sea Carrying Capacity (Coastal Ocean Program), the Bering Sea Green Belt: processes and ecosystem production (Arctic Research Initiative) and Prolonged Production and Trophic Transfer to Predators: processes at the inner front of the southeast Bering Sea (National Science Foundation). This research seeks to improve our understanding of ecosystems through the integration of physical and biological phenomena.

During January – August 2000, the Bering Sea was characterized by an early and extensive build-up of sea ice and an early retreat, a May phytoplankton bloom and a reoccurrence of the coccolithophorid bloom. While some of the salmon returns were typical, others were well below expected. The present status of the Bering Sea is a continuation of long-term influences that have resulted in significant changes in the ecosystem in recent years. These include fluctuation in the number of returning salmon, recurring coccolithophorid bloom, increasing numbers of jelly fish and continuing decreases in the Steller sea lion and fur seal populations. Many of the changes in this ecosystem can be attributed to shifts in decadal patterns of climate.

Great year-to-year variability is evident in the climate of the Bering Sea, but it is also sensitive to changes on decadal and longer time scales. For example, the Bering Sea responds to two dominant decadal oscillations of the North Pacific, the Pacific Decadal Oscillation (PDO) and the Arctic Oscillation (AO). The PDO is the first mode of decadal variability in the sea surface temperature of the North Pacific and is strongly coupled to the sea level pressure pattern and thus to changes in near-surface winds. Its impact on the Bering Sea is largely limited to the southern portion. The AO is a mode of variability of atmospheric pressure and is associated with the spin up of the polar vortex. When in its negative state, higher-than-normal pressure occurs over the Arctic and weaker-than-normal pressure over the mid-latitudes. When in its positive mode, there is an increase in the poleward transport of heat. The AO not only impacts the Arctic and the Bering Sea, but is also a source of variability for the Northern Hemisphere.

It is generally recognized that a regime shift occurred in 1977 when both the AO and PDO changed sign. Historically, a negative PDO has been associated with more extensive and persistent ice cover over the Bring Sea shelf. In the decade previous to the shift there was a series of cold years, with maximum ice extent over the eastern Bering Sea shelf. From 1977-1989, ice was less common over the southeastern shelf than was typical during the previous regime. In 1989, the AO changed sign and while conditions did not return to the cold years of the early 70s, the patterns of ice coverage changed. After the shift in the AO, ice persisted longer in the spring south of 61°N and west of 168°W, while to the north earlier ice retreats occurred. Coinciding with the early ice retreat is a warming of 3-4°C at 850mb in April over the Arctic during the last decade. Much of the warming is centered over North America, stretching from the Bering to Greenland. This warming is associated with anomalously stronger winds from the south. In essence, these observations, together with others such as earlier snow melt over parts of Alaska, indicate an earlier transition from winter to ecosystem.

In 1997, the PDO changed sign (from positive to negative). It is not known whether a regime shift has occurred or if this represents shorter-term variability that is characteristic of the Bering Sea. The PDO has remained negative through July 2000, although its magnitude has decreased in spring and summer 2000. One expected impact of a change in the PDO would be in the extent and duration of ice cover. In December 1999, strong, cold northerly winds created ice in polynyas and advected it southward over the shelf. By January 2000, the eastern Bering Sea shelf (Fig. 1) was largely covered with ice. This early ice cover was more extensive than what occurred in January during the cold decade before 1977. In early February, the winds reversed and blew the ice northward, resulting in a largely ice-free southern shelf. Surprisingly, these conditions persisted for the rest of the winter and early spring.

For the last six years, a series of biophysical moorings have been deployed at 56.9^{o}N, 164^{o}W over the Bering Sea shelf. This mooring site is located near the center (70m isobath) of the middle shelf. Instruments measuring temperature, salinity, fluorescence, nitrate and currents are deployed year around. Shown in Figure 2 are temperature data from spring and summer of the last six years. The pattern of sea surface temperature (SST) is fairly consistent. Coldest temperatures occur after the retreat of the ice. In 1999, that occurred in early May, but more typically it occurs in February or March. From April (if the shelf is ice-free) through August, solar insolation begins to heat the system. During April and May 2000, SST was similar to what had been observed in 1995-1997. Later in the summer conditions were cooler than average, but not as cold as was observed in 1999. The depth-averaged temperature also fell between the extremes of 1999 (cold) and 1998 (warm), although warming continued longer (through August) than previously observed. If ice had persisted over the shelf through March, the initial temperatures would have been cooler, resulting in cooler summer temperatures. The timing of retreat of ice is critical to the set up of the temperature on the shelf. Just as the persistence of ice into May of 1999 contributed to the cold depth-averaged temperatures throughout the remainder of the year over the shelf, the early retreat of ice in 2000, resulted in average initial conditions that persisted through the year.

For the fourth year in a row there was a coccolithophore bloom over the eastern Bering Sea shelf. Coccolithophores are small, photosynthetic cells covered by calcareous plates (liths), from which light reflects giving the water its distinctive milky white color. While in the previous three years (1997, 1998, and 1999) the bloom appeared in early July, in 2000 it was delayed until late July. Cruises in early July found no evidence of the bloom over the southeastern shelf. By August, the milky water once again covered a significant portion of the eastern Bering Sea shelf. The cause of the late arrival of the bloom is unclear. It is likely not a result of colder temperature, since 1999 was cooler than 2000.

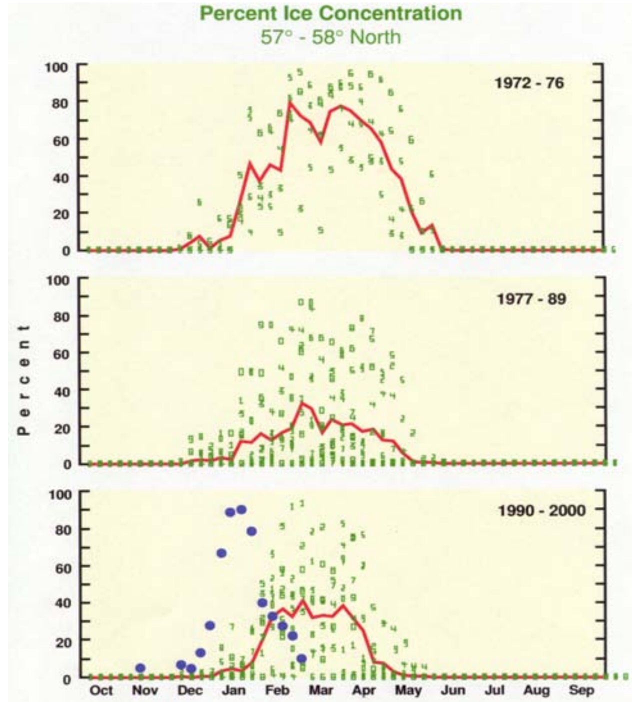

Fig. 1 Percent ice concentration during three regimes: a) 1972-1976, b) 1977-1989 and c) 1990-1999, in the one degree band (57^{o}-58^{o}N) across the Bering Sea shelf. The blue dots in the third panel are for 2000.

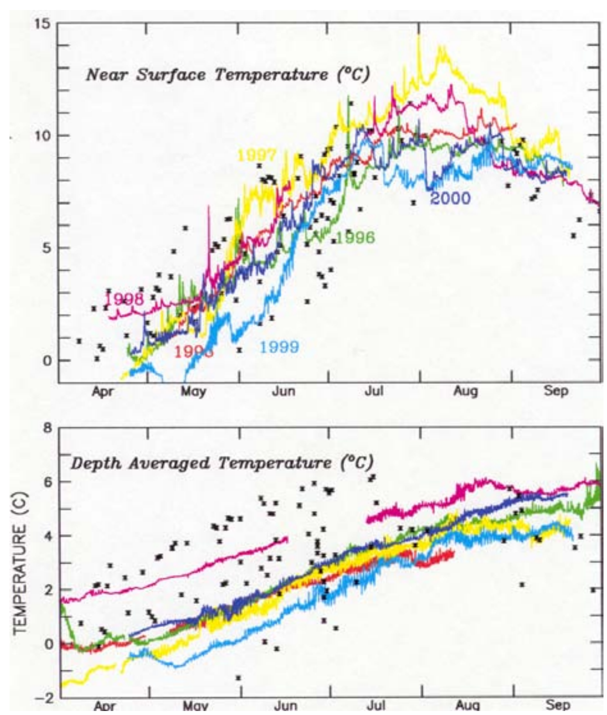

Fig. 2 a) Sea surface temperature at Site 2 on the southeastern Bering Sea shelf (56.9^{o}N, 164^{o}W) for the six years that a biophysical mooring has been deployed at this site. b) The depth-averaged temperature at Site 2 for the same years in a). The x's are historical data near the mooring site.